

REMARKS/ARGUMENTS

Favorable reconsideration of this application in light of the following discussion is respectfully requested.

Claims 6-8, 10-13, and 15-19 remain active in this case, Claims 6, 12, and 17-19 having been amended, Claims 9 and 14 having been canceled without prejudice or disclaimer, and Claims 1-5 having been withdrawn from consideration as directed to a non-elected invention. Support for the amendment to Claim 6 is found, for example, in original Claim 9. Claims 12 and 17-19 are amended to correct grammatical informalities. Applicants respectfully submit that no new matter is added.

In the outstanding Office Action, the title was objected to as being insufficiently descriptive; Claims 9 and 14 were rejected under 35 USC §112, 2nd para., as being indefinite; Claims 6-8, 10-13, 15-19 were rejected under 35 USC §103 as being unpatentable over Besser et al (U.S. patent publication no. 2003/0235984, hereinafter Besser); and Claims 9 and 14 were rejected under 35 USC §103(a) as unpatentable over Besser in view of Bohr (U.S. Patent Publication No. 2004/0061184).

In response to the objection to the title, the title has been amended consistent with the elected invention and consistent with page 1, lines 15-16 of the specification. Accordingly, Applicants respectfully submit that the objection to the title is overcome.

With respect to rejection of Claims 9 and 14 under 35 USC §112, second paragraph, Applicants respectfully submit that this ground of rejection is moot in view of the cancellation of Claims 9 and 14.

Furthermore, as Claim 6 is amended to include the subject matter of Claim 9, Applicants respectfully submit that Claim 6 satisfies the requirements of 35 U.S.C. §112, second paragraph. As suggested in the outstanding Office Action, Claim 6 is amended to recite “a plug of metal material containing copper formed in the insulating layer.”

Furthermore, Applicants note that the specification is amended to correct an informality.

With respect to the rejections based on art, Applicants respectfully submit that amended Claim 6 patentably distinguishes over Besser, Lu, and Bohr, taken alone or in proper combination. Amended Claim 6 recites, *inter alia*,

an NiSi layer formed on the source and drain regions;

a plug of a metal material containing copper formed in the insulating layer so as to be electrically in contact with the NiSi layer,

wherein a junction depth of the source and drain regions ranges from 20 nm to 60 nm from a lower surface of the NiSi layer, Ni atoms exist in the source and drain regions, and a concentration of the Ni atoms at the junction depth being at $1.6 \times 10^{14} \text{ cm}^{-3}$ or less.

Applicants respectfully submit that Besser, Lu, and Bohr do not disclose or suggest these elements of amended Claim 6.

The present inventors have established a clear one-to-one correspondence between leakage current and Ni concentration relevant to NiSi induced leakage, which is by no means obvious. This is so because Ni in Si could form various physical configurations depending on the level of Ni supersaturation in the Si matrix and how Ni atoms are injected into Si. Accordingly, leakage-generating ability of Ni could differ significantly depending on the forms of the Ni in Si.

With respect to Ni injected into the substrate from an already formed NiSi layer by a heat stimulus, the present inventors have discovered that a universal one-to-one correspondence between leakage level and Ni concentration holds irrespective of the annealing time. Furthermore, the present inventors have discovered that the most crucial determinant factor governing leakage generation associated with NiSi induced leakage is the

process temperature applied after the silicidation process, and not the silicidation temperature itself. It is noted that heat stimuli during and after the reaction could have different effects.

Conventional thinking is that NiSi is maintained leakage-free below the phase transition temperature (750° C) from NiSi toward NiSi₂. Thus, any post-silicide processing below this phase temperature is thought to be harmless. Nonetheless, precipitous leakage generation above a certain temperature, i.e., the presence of a critical temperature far below the expected phase transition temperature, has been discovered for the first time by the present inventors.

The presence of such a critical temperature is totally unexpected because it is not predicted by the material properties of NiSi bulk. Only with the finding of the critical temperature by the present inventors, a clear demarcation of an unexpected critical limitation on the tolerable post-silicide process temperature was made possible.

Thus, the claimed Ni concentration, after the formation of the insulating layer and metallization, unequivocally signifies that a heat treatment temperature after the formation of NiSi (for example, a temperature for manufacturing the insulating layer or the plug of the metal) is lower than a certain critical temperature (*see* specification at page 14, line 8 to page 15, line 22).

Therefore, the claimed invention has the advantage that it prevents the Ni infiltration from the NiSi layer to the silicon substrate, thereby preventing the generation of a junction leakage current (*see* specification at page 24, lines 10-12).

When rejecting Claim 6, the outstanding Office Action relies on paragraph [0046] of Besser. However, paragraph [0046] describes a first RTA process that yields Ni₂Si and a second RTA process that yields NiSi. However, Besser does not disclose or suggest that a heat treatment temperature after the formation of NiSi is lower than a certain critical temperature.

Furthermore, Lu and Bohr do not disclose or suggest that a heat treatment temperature after the formation of NiSi is lower than a certain critical temperature.

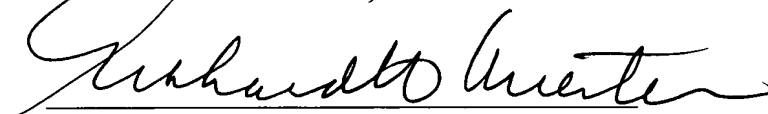
Applicants respectfully submit that even if the disclosures of Besser, Lu, and Bohr were combined, it would not be possible to prevent the Ni infiltration from the NiSi layer to the silicon substrate, and to prevent the generation of a junction leakage current.

In view of the above-noted distinctions, Applicants respectfully submit that Claim 6 (and Claims 7, 8, 10-13, and 15-19 dependent thereon) patentably distinguish over Besser, Lu, and Bohr, taken alone or in proper combination.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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